

David Zhao Akeley

PhD Student at MIT CSAIL

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Work Email	akeley98[at]mit.edu	UCLA Degrees	BS Computer Science, BS Mathematics
SMS	1-408-763-5241	UCLA GPA	3.762

Work History

MIT CSAIL – September 2024 - Present – PhD Student

New PhD student advised by [Jonathan Ragan-Kelley](#)

Nvidia Corporation – October 2020 - June 2024 – Developer Technology Engineer (IC3)

1. Collaborated with Nvidia Research on GPU algorithms for SDF-based¹ 2D computational geometry. “How to Accelerate 2D Shape Processing for Manufacturing and Planning” - [GTC 2023](#) (s51140)
2. Wrote Vulkan samples for `VK_EXT_graphics_pipeline_library`, `VK_KHR_timeline_semaphore`, `GL_KHR_shader_subgroup_shuffle`, `VK_NV_inherited_viewport_scissor`, and ray tracing extensions.
3. Designed `VK_NV_inherited_viewport_scissor` and implemented its driver and toolchain support.
4. Consulted with business partners on integrating Nvidia technology: DMM, `GL_NV_path_rendering`.

Sholari LLC – July - September 2019 – Contractor

1. Worked on a tumor growth and treatment educational tool written with the Unity game engine.
2. Implemented line graphs, waterfall (bar) plots, and the user interface for the timeline (graph x-axis).
3. Wrote a multithreaded C++11 plugin for visualizing tumors & immune system responses as particle clouds, and integrated it with the single-threaded C# Unity Engine.

Stanford University – June - September 2018 – Undergraduate Research Assistant

1. Helped prototype Aetherling, a Haskell-embedded domain-specific language for designing hardware image processing pipelines with automatic parallelization and static scheduling²; co-authored paper with [David Durst](#) (lead author), [Dr. Kayvon Fatahalian](#), and [Dr. Pat Hanrahan](#).
2. Implemented a functional simulator of an early prototype of Aetherling.
3. Revised the type system to remove impediments to parallelizing line buffers.³

<https://aetherling.org> (“Type-Directed Scheduling of Streaming Accelerators” - PLDI 2020)

MediocrePy – March - June 2017 – Independent Project

1. Created an optimized library for reducing stacks of telescope images to a single image using pixel means or medians and optional outlier rejection (sigma clipping) for noise reduction.
2. Designed and implemented a multithreaded C core with AVX vectorization, with an optional NumPy wrapper. Decreased runtime (compared to the Python code replaced) from hours to milliseconds.
3. Collaborated with [Dr. Zheng Cai](#), UC Santa Cruz Astrophysics.

<https://github.com/akeley98/MediocrePy>

Tsinghua University – July - August 2016 – Summer Intern

1. Designed a small library for fitting and plotting standard microlensing event light curves given discrete measurements of a star’s apparent magnitude (brightness) through time.
2. Used Python, C++, SciPy, and Matplotlib.
3. Collaborated with [Dr. Shude Mao](#), Tsinghua Department of Astronomy.

¹Signed Distance Field

²i.e. not using ready-valid hardware interfaces.

³A line buffer device reads in an image as a stream of pixel values and outputs rectangular “windows” of the image.

Jide Technology Co. – June - July 2015 – Summer Intern

1. Performed product testing for RemixOS, an Android derivative with a desktop-like interface.
2. Edited international marketing material and wrote user documentation in English.
3. Collaborated with Jason Zheng and Jeff Zhao (International Marketing Manager).

Other Projects

WebGL Jelly Cube Project

Simple mass-spring system simulation written with Javascript, WebAssembly, and WebGL 2.0 (for refractive and reflective effects), written for the UCLA Fall 2017 computer graphics class.

<https://github.com/akeley98/JellyMcJelloFace>

<https://youtu.be/YwvMSeB6NzU>

Myricube – Vulkan Voxel Renderer

This proof-of-concept hybrid raycast/mesh voxel rendering was inspired by my discontent with Minecraft's low render distance and slow chunk updates, even on high settings.

Conventional voxel renderers such as Minecraft's work by converting voxel models into a mesh of triangles to draw, possibly with some optimizations like hidden face removal or merging coplanar triangles. This uses the GPU for its designed purpose, but as render distance increases, the GPU is bottlenecked by the large number of small triangles generated. Myricube uses conventional mesh rendering⁴ for nearby voxels but draws more distant voxels with an alternative raycasting renderer. This renderer subdivides the voxel model into cubic chunks, computes a minimal AABB⁵ for each chunk's visible voxels, and draws the AABBs themselves with a raycasting fragment shader that only checks for intersections within the drawn AABB. Dividing the model into AABBs reduces the renderer's memory bandwidth requirements and time wasted raycasting through empty space, without requiring any acceleration structures be built.

Additionally, the project leverages memory-mapped files and Vulkan asynchronous transfers to allow for low-latency, high-throughput model upload and real-time animation.

<https://github.com/akeley98/myricube>

Proposed gem5 Hardware Simulator Partial Bypassing Patch

This patch is refactored C++11 code that I wrote for my Advanced Computer Architecture course project.

In an out-of-order CPU, hardware bypassing allows instructions stalled waiting for a register to start execution as soon as the functional unit (ALU, memory port, etc.) writing to said register completes, without waiting for the actual commitment to register file. This is crucial for performance, so mainline gem5 simulates complete bypassing between all functional units in the simulated CPU. However, this is not practical to realize in modern superscalar hardware, as bypassing costs grow quadratically with the number of functional units. My patch splits the CPU's functional units into separate pools, with bypassing simulated only within pools. The commit-to-register-file delay is imposed for values communicated between pools.

The patch received positive code reviews; however, it doesn't look like there's enough interest in the feature to actually merge it into mainline gem5.

<https://gem5-review.googlesource.com/c/public/gem5/+27767>

<https://github.com/akeley98/FU-pools/blob/b4d291429edb6aa4988888656b6867ff99591b90/fu-pools.pdf>

⁴More precisely, instanced rendering to convert subsets of a list of voxels into a mesh to draw.

⁵Axis aligned bounding box – requires only six front-facing triangles to draw.

Appendix: UCLA Education – September 2017 - August 2020

	First Major	Computer Science	Second Major	Mathematics	GPA	3.762 (August 2020)
		Title		Content	Notes	
2017	A+	CS 174A	Intro to Computer Graphics	See WebGL Jelly Cube Project		
	A+	EE M16	Digital Systems	Verilog Lab		
	A+	Math 115A	Linear Algebra			
	A	Math 170A	Probability Theory			
2018	A	CS 35L	Software Construction Lab	POSIX basics (e.g. pthreads, bash)		
	A	CS M146	Machine Learning			
	A	Math 110A	Algebra	Ring Theory		
	A	Math 131AH	Analysis Honors	Metric Spaces		
	A+	CS 180	Algorithms & Complexity			
	A	Engr 185EW	Art of Engineering Endeavors	Writing Intensive Team Project		
	A	Math 131BH	Analysis Honors	Derivation, Riemann Integration		
	B-	CS 131	Programming Languages			
	B+	CS M152A	Digital Design Lab	Verilog Team Project		
	B+	Math 110AH	Algebra Honors	Group Theory		
	C	Math 120A	Differential Geometry			
2019	A-	CS 111	Operating Systems Principles	Focus on POSIX		
	A+	CS 181	Formal Languages & Automata	Regex, CFG, Turing Machines, Decidability		
	A-	Math 132H	Complex Analysis Honors			
	A-	CS 161	Fundamentals of Artificial Intelligence			
	A+	EE M116C	Computer Systems Architecture			
	B+	Math 111	Theory of Numbers	Overview of p-adic Numbers		
	A-	CS 118	Computer Network Fundamentals			
	B	CS 130	Software Engineering	Java Team Project		
	A	Math 134	Systems of Differential Equations			
	A+	CS 133	Parallel & Distributed Computing	OpenMP, OpenCL, MPI, GPGPU, FPGA		
2020	A+	CS 251A	Advanced Computer Architecture	gem5 Hardware Sim Project, Graduate Course		
	A	Math 110BH	Algebra Honors	Ring Theory, Module Theory		
	A	Math 110C	Algebra*	Field Theory, Galois Theory		
	A	Math 115B	Linear Algebra			
	A	Math 142	Mathematical Modeling			
	A+	Math 167	Game Theory			

*There is no honors equivalent to the Galois Theory Course.

West Valley College Education – 2015-2017

GPA 4.0

Select Courses

	Title	Content	Notes
Math 4B	Differential Equations		
Math 19	Discrete Mathematics		
Psych 2	Experimental Psychophysiology	Experiment Design & Paper	
Phys 4D	Modern Physics	Relativity	

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